ENGINEERING-SCIENCE, INC.

1700 Broadway, Suite 900 • Denver, Colorado 80290 • (303) 831-8100 • Fax: (303) 831-8208

June 9, 1994

Mr. Marty Faile
AFCEE/ERT
8001 Arnold Drive
Brooks AFB, Texas 78235-5357

RE: AFCEE Bioventing Test Initiative Final Tables

Dear Marty:

Please find attached final tables and site figures for several sites at which 12 months of bioventing pilot testing have been completed. Specifically, final tables are attached for FE. Warren AFB - Spill Site 1; Hill AFB sites - Building 924, Building 204.1, Building 228, and Building 214; KI Sawyer AFB - IRP Site ST-04 POL Area; Battle Creek ANGB - IRP Site 3 Fire Training Area; Tinker AFB - POL Area 3; Kelly AFB - Site FC-2; Beale AFB - Site 3 and Site 18; and Charleston AFB Site FT-03. AFCEE has previously received final tables for many of these sites. The attached tables have been updated and now include the method detection limits where previously no detection limit was reported. Final figures for Charleston AFB Site FT-03 will be forwarded to you in the near future. Please call me at (303) 831-8100 if you have any questions.

Sincerely,

ENGINEERING-SCIENCE, INC.

Brian Blicker

Brian Blicker
Environmental Engineer

c.c.: Doug Downey
File

PARSONS

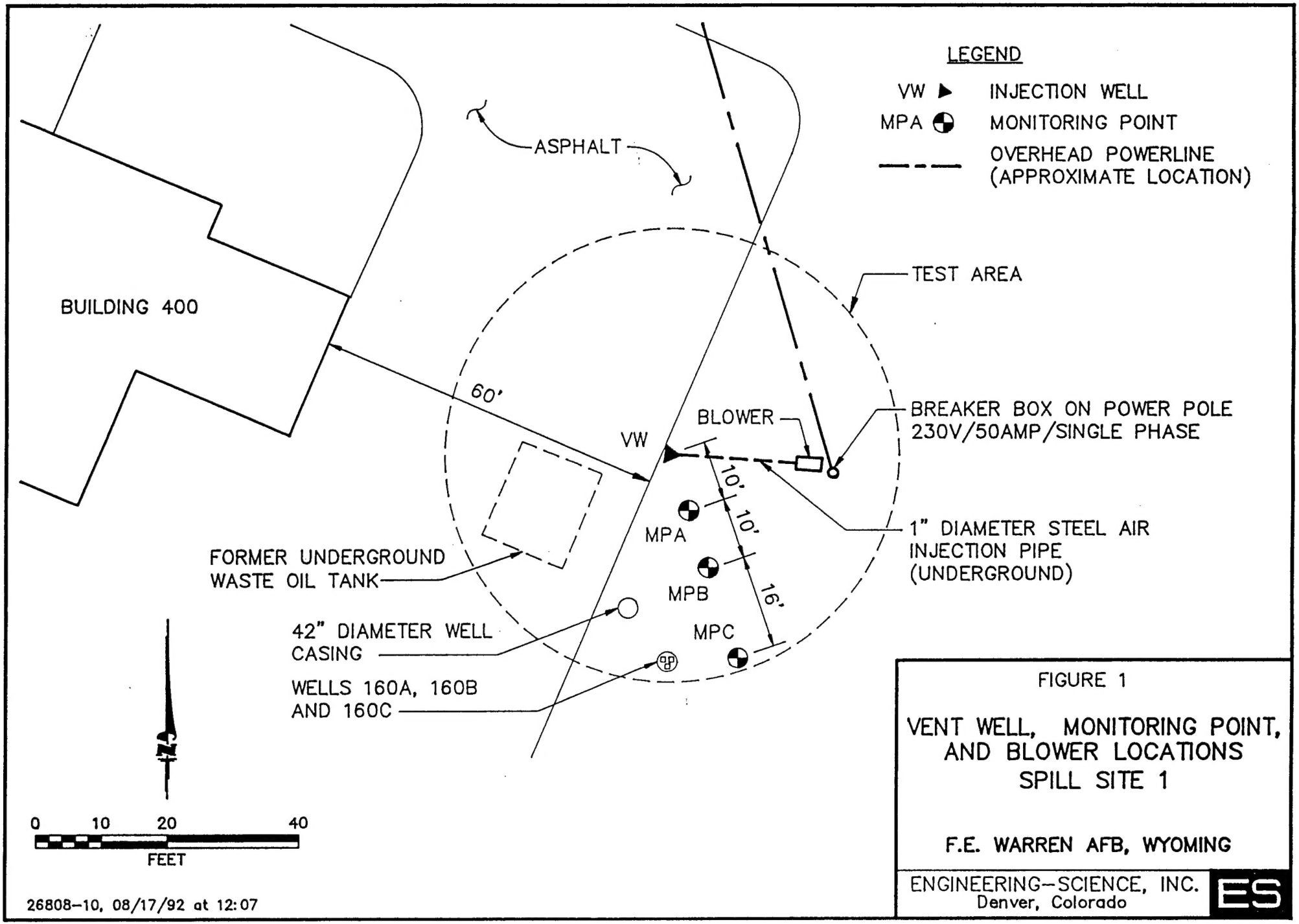


FIGURE 1

VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS SPILL SITE 1

F.E. WARREN AFB, WYOMING

ENGINEERING-SCIENCE, INC.
Denver, Colorado
ES

TABLE 1
SPILL SITE 1
RESPIRATION AND DEGRADATION RATES
F.E. WARREN AFB, WYOMING

Location–Depth	Initial			6–Month[b/]			1–Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA–11	0.004	362	11.8	0.0003	33	14.3	0.0001	13	NS[c/]
MPB–11	0.048	1835	NS	0.002	133	NS	0.0007	66	NS
MPC–11	0.018	1449	NS	0.0003	20	NS	0.0001	9	NS

[a/] Milligrams hydrocarbons per kilogram soil per year.
[b/] Assumes moisture content of the soil is the same as the initial readings.
[c/] Not sampled.

TABLE 2
SPILL SITE 1
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
F.E. WARREN AFB, WYOMING

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)					
	MPA-11		MPB-11		MPC-11	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	22	38	42,000	34	4,200	27
Benzene (ppmv)	0.093	<0.002	480	<0.002	68	<0.002
Toluene (ppmv)	0.043	0.017	81	0.010	1.6	0.008
Ethylbenzene (ppmv)	0.020	0.058	68	0.058	4.1	0.030
Xylenes (ppmv)	0.079	0.400	320	0.210	19	0.210
	MPA-11		MPB-10		MPC-11	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	29	7.3	920	380	250	1,720
Benzene (mg/kg)	<0.0019	<0.003	<0.77	<0.077	<0.38	<3.2
Toluene (mg/kg)	<0.0022	<0.003	<0.9	0.31	<0.44	12
Ethylbenzene (mg/kg)	<0.0016	<0.003	4.9	<0.077	8.2	<3.2
Xylenes (mg/kg)	0.13	0.0045	34	0.87	51	29
Moisture (%)	19.5	17	22.4	19	20.5	21

[a/] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram; TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
[b/] Initial soil gas samples collected on September 11, 1992.
[c/] 1-Year soil gas samples collected on October 27, 1993.
[d/] Initial soil samples collected on September 9 and 10, 1992.
[e/] 1-Year soil samples collected on October 25, 1993.

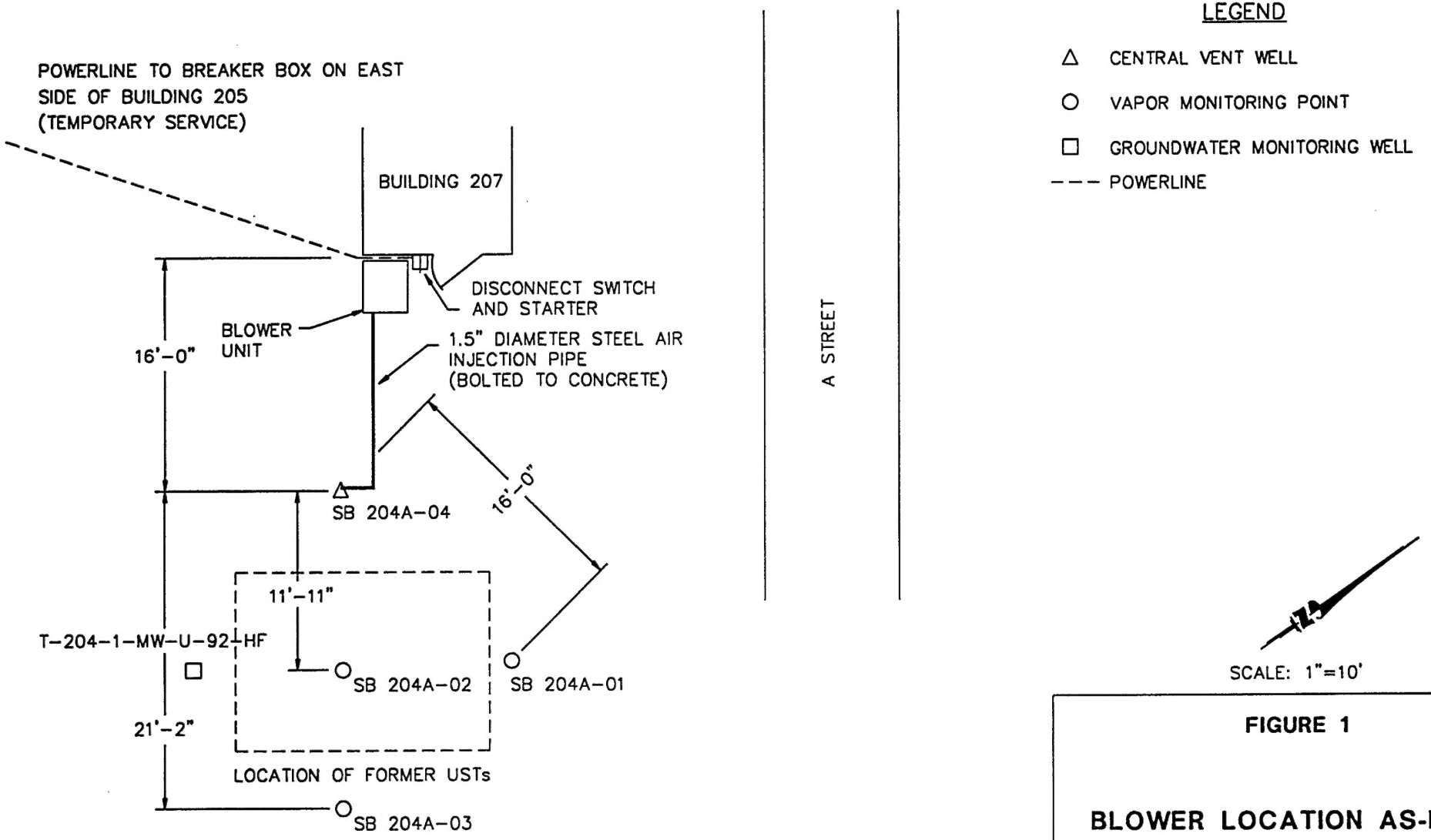


FIGURE 1

BLOWER LOCATION AS-BUILT SITE 204.1

HILL AFB, UTAH

ENGINEERING-SCIENCE, INC.

Denver, Colorado

26809-01, 06/30/93 at 14:39

TABLE 1
SITE 204.1
RESPIRATION AND DEGRADATION RATES
HILL AFB, UTAH

Location (Depth, feet bgs)	Initial (July 1992)			6-Month (Feb.-Mar. 1993)			1-Year (July 1993)		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/ b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
SB204A-04 (10-50)[c/]	.026	9800	NS[d/]	.0021	790	NS	.0017	640	NS
SB204A-01 (27-28)	NS	NS	NS	0.00049	160[e/]	NS	NS	NS	NS
SB204A-01 (34-35)	.0062	2700	NS	.0008	350	NS	.0005	220	NS
SB204A-02 (11-12)	.017	3000	NS	NS	NS	NS	.0026	470	NS
SB204A-03 (12-13)	NS	NS	NS	.0004	130[e/]	NS	NS	NS	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Calculated using moisture content of soil sample collected from the location in July 1993.
[c/] Vent well.
[d/] Well installation was performed by another contractor, no thermocouples were installed. NS=Not Sampled.
[e/] Assumes average moisture content of the soil samples collected in July 1993.

TABLE 2
SITE 204.1
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HILL AFB, UTAH

Analyte (Units)[a/]	Sample Location (Depth, feet below ground surface)					
	SB204A-04 (10-50)[b/]		SB204A-01 (34-35)		SB204A-02 (11-12)	
Soil Gas Hydrocarbons	Initial[c/]	1-Year[d/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	490	7.6	7.5	0.27	160	1.7
Benzene (ppmv)	.016	.005	.010	<.002	.053	<.003
Toluene (ppmv)	.25	.009	.006	<.002	.060	.004
Ethylbenzene (ppmv)	.17	<.002	<.002	<.002	.085	<.003
Xylenes (ppmv)	.85	.003	<.002	<.002	.31	.003

	SB204A-04 (12.5-13)		SB204A-01 (9-9.5)		SB204A-02 (11-12)	
Soil Hydrocarbons	Initial[e/]	1-Year[f/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1500	660	370	1750	1000	11200
Benzene (mg/kg)	.023	<.03	.009	<.0003	.031	<.03
Toluene (mg/kg)	.26	<.03	<.005	.0004	.22	<.03
Ethylbenzene (mg/kg)	.78	<.03	.047	<.0003	.8	<.03
Xylenes (mg/kg)	7.4	<.03	.19	<.0007	7.7	.25
Moisture (%)	NS[g/]	5.0	4.8[h/]	3.0	NS	15.0

[a/] TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.
[b/] Vent well.
[c/] Initial soil gas samples collected on 7/7/92.
[d/] 1-Year soil gas samples collected on 7/19/93.
[e/] Initial soil samples collected by Montgomery-Watson, Inc. from 5/4/92 to 5/7/92.
[f/] 1-Year soil samples collected on 8/10/93.
[g/] NS=Not Sampled.
[h/] Average soil moisture content of analytical samples collected from borehole SB204A-01.

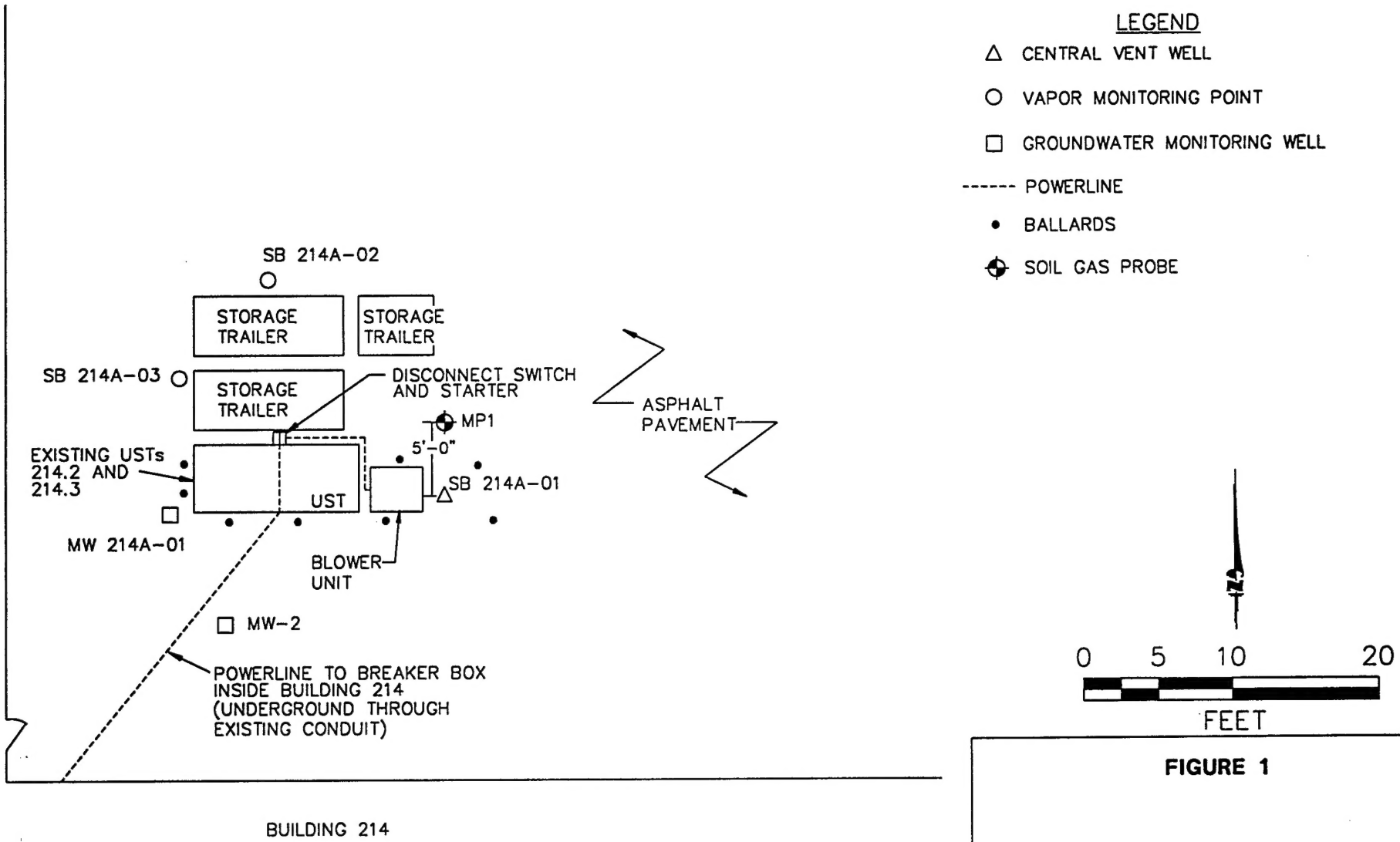


FIGURE 1

BLOWER LOCATION AS-BUILT
SITE 214.1

HILL AFB, UTAH

ENGINEERING-SCIENCE, INC.
Denver, Colorado

26809-02, 06/30/93 at 13:34

TABLE 1
SITE 214.1
RESPIRATION AND DEGRADATION RATES
HILL AFB, UTAH

Location (Depth, feet bgs)	Initial (July 1992)			6-Month (Feb.-Mar. 1993)			1-Year (July 1993)		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)
SB214A-01 (5-60)[c/]	0.0051[d/]	540	NS[e/]	.00025	27	NS	.00025	27	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Assumes moisture content of the soil is the same as the initial level at SB214A-01.
[c/] Vent well.
[d/] Temporary vapor probe MP-1 was installed at 12 feet below grade 5 feet north of SB214A-01 for initial testing.
[e/] Well installation was performed by another contractor, no thermocouples were installed. NS=Not Sampled.

TABLE 2
SITE 214.1
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HILL AFB, UTAH

Analyte (Units)[a/]	Sample Location (Depth, feet below ground surface)	
	SB214A-01 (5-60)	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]
TVH (ppmv)	960	620
Benzene (ppmv)	.019	<.029
Toluene (ppmv)	.076	<.029
Ethylbenzene (ppmv)	.52	.036
Xylenes (ppmv)	.51	.18
	SB214A-01 (11-12)	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]
TRPH (mg/kg)	36200	550
Benzene (mg/kg)	<.05	<.0002
Toluene (mg/kg)	1.15	<.0002
Ethylbenzene (mg/kg)	5.84	<.0002
Xylenes (mg/kg)	65.8	<.0002
Moisture (%)	19.0	NS[f/]

[a/] TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.
[b/] Initial soil gas sample collected on 7/7/92.
[c/] 1-Year soil gas sample collected on 7/19/93.
[d/] Initial soil samples collected by Montgomery-Watson, Inc. on 11/1/91.
[e/] 1-Year soil sample collected on 8/3/93.
[f/] NS=Not Sampled.

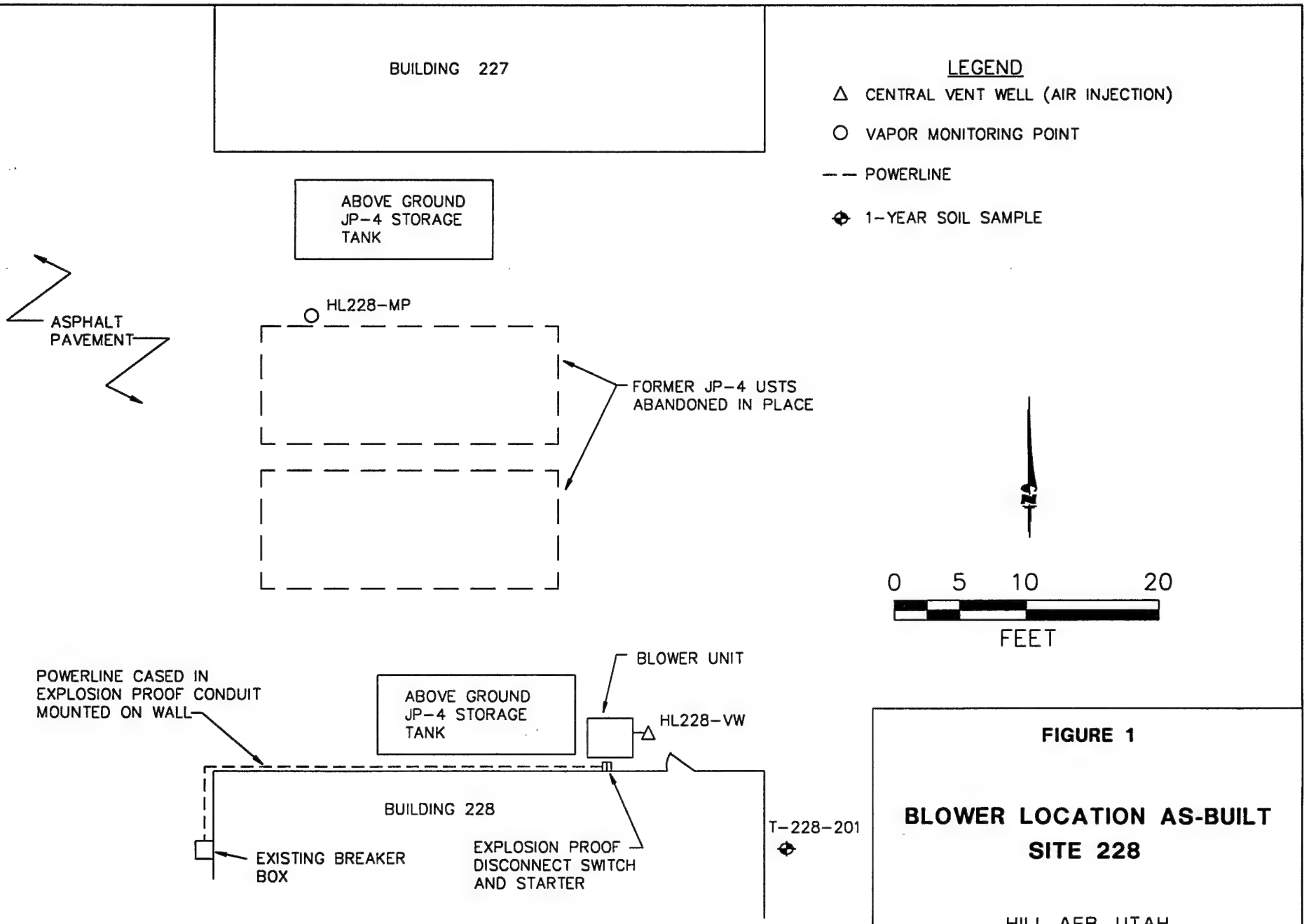


FIGURE 1

BLOWER LOCATION AS-BUILT
SITE 228

HILL AFB, UTAH

ENGINEERING-SCIENCE, INC.
Denver, Colorado

26809-11. 06/30/93 at 13:45

TABLE 1
SITE 228
RESPIRATION AND DEGRADATION RATES
HILL AFB, UTAH

Location (Depth, feet bgs)	Initial (July 1992)			6-Month (Feb.-Mar. 1993)			1-Year (July 1993)		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)
HL228-VW (10-40)	NS[c/]	NS	NS[d/]	.00004	10	NS	.00007	17	NS
HL228-MP (28-29)	.009	2200	NS	.001	250	NS	.0019	470	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Assumes moisture content of the soil is the same as the initial level at HL228-VW.
[c/] NS=Not Sampled.
[d/] Well installation was performed by another contractor, no thermocouples were installed.

TABLE 2
SITE 228
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HILL AFB, UTAH

Analyte (Units)[a/]	Sample Location (Depth, feet below ground surface)			
	HL228-VW (10-40)		HL228-MP (28-29)	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/ d/]	Initial[d/]	1-Year[d/]
TVH (ppmv)	42	27	2700	12
Benzene (ppmv)	.06	.03	1.55	.012
Toluene (ppmv)	.009	.0135	4.4	.044
Ethylbenzene (ppmv)	.002	.019	1.7	.013
Xylenes (ppmv)	.018	.205	9.45	.051

	HL228-VW (27.5-28)		HL228-MP (28-28.5)	
Soil Hydrocarbons	Initial[e/]	1-Year[f/]	Initial	1-Year[g/]
TRPH (mg/kg)	5000	<5.4	6,500	NS[h/]
Benzene (mg/kg)	1.2	<.0006	0.08	NS
Toluene (mg/kg)	12	<.0006	6.3	NS
Ethylbenzene (mg/kg)	6.1	<.0006	8.1	NS
Xylenes (mg/kg)	220	<.0008	260	NS
Moisture (%)	11.7[i/]	8.0	NS	NS

[a/] TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.
[b/] Initial soil gas samples collected on 7/6/92 and 7/7/92.
[c/] 1-Year soil gas samples collected on 7/19/93.
[d/] Average of two duplicate samples.
[e/] Initial soil samples collected by Montgomery-Watson, Inc. on 5/18/92.
[f/] 1-Year soil samples collected at location T-228-201 (28.5-29) on 9/11/93.
[g/] Sample could not be collected due to presence of underground utilities.
[h/] NS=Not Sampled.
[i/] Average soil moisture content from samples collected at HL228-VW.

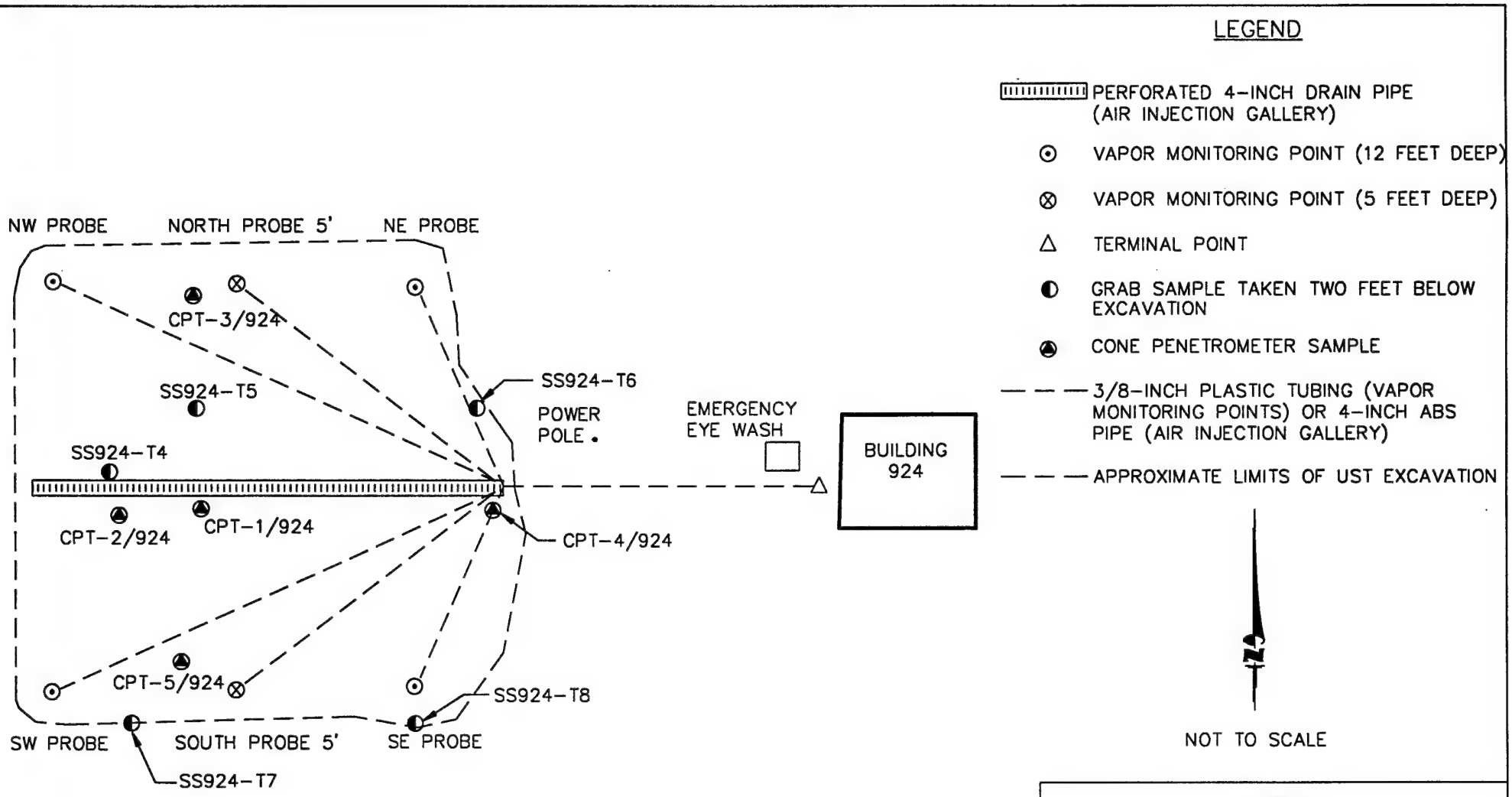


FIGURE 1

BLOWER LOCATION AS-BUILT
SITE 924

HILL AFB, UTAH

ENGINEERING-SCIENCE, INC.
Denver, Colorado

26809-04, 06/24/92 at 15:30

TABLE 1
SITE 924
RESPIRATION AND DEGRADATION RATES
HILL AFB, UTAH

Location (Depth, feet bgs)	Initial (July 1992)			6-Month (March 1993)			1-Year (July 1993)		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/ b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)
HL924-VW (12)	.014	5000	NS[c/]	NS	NS	NS	.00008	28	NS
HL924-SE (12)	.013	4600	NS	.0012	430	NS	.00018	64	NS
HL924-S (5)	.009	3200	NS	NS[d/]	NS	NS	NS	NS	NS
HL924-SW (12)	.0011	390	NS	.00024	85	NS	.00009	32	NS

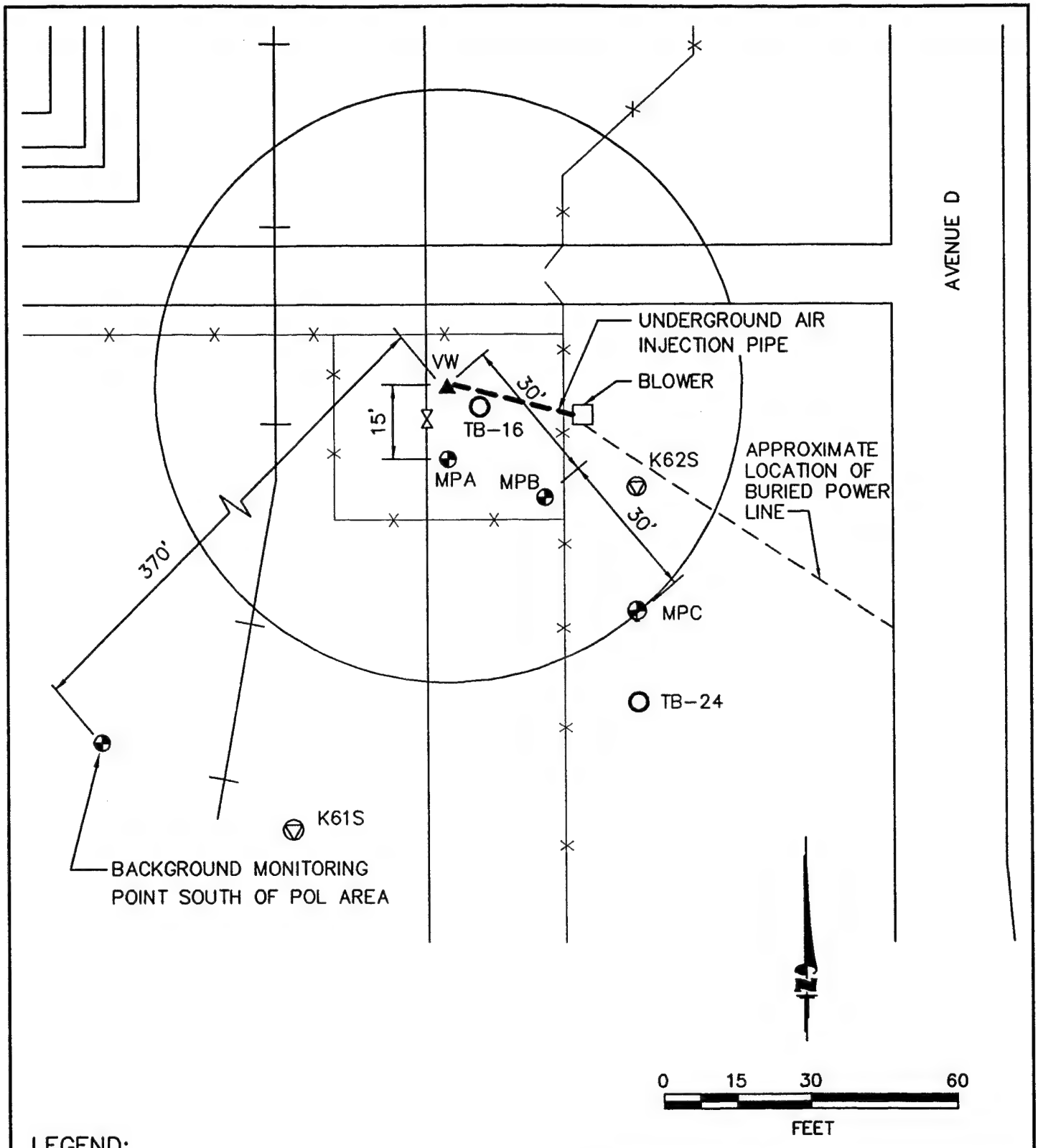
[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Calculated using average moisture content of soil samples collected from Site 924.5, north of Bldg 924.
[c/] Well installation was completed by another contractor, no thermocouples were installed. NS=Not Sampled.
[d/] Monitoring point HL924-S was destroyed during site construction activity in Fall 1992.

TABLE 2
SITE 924
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
HILL AFB, UTAH

Analyte (Units)[a/]	Sample Location (Depth, feet below ground surface)					
	HL-924-VW (12)		HL-924-SE (12)		HL-924-S (5)	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial[d/]	1-Year[d/]	Initial	1-Year[e/]
TVH (ppmv)	13	.27	4800	2.75	1800	NS
Benzene (ppmv)	.016	<.002	61	.004	15	NS
Toluene (ppmv)	.12	.006	145	.003	30	NS
Ethylbenzene (ppmv)	.013	<.002	6.7	<.003	1	NS
Xylenes (ppmv)	.16	<.002	63.5	<.003	8.6	NS

	SS924-T4 (14)	SS924-T5 (14)	SS924-T6 (14)	SS924-T7 (14)	SS924-T8 (14)	CPT-1/924 (30-30.5)	CPT-2/924 (30-30.5)	CPT-3/924 (25-25.5)	CPT-4/924 (20-20.5)	CPT-5/924 (10-10.5)
Soil Hydrocarbons	Initial[f/]					1-Year[g/]				
TRPH (mg/kg)	<1.0	<1.0	<1.0	<1.0	14.7	<10.0	<10.0	<10.0	<10.0	<10.0
Benzene (mg/kg)	<0.2	<0.2	<0.2	<0.2	<0.2	<.01	<.01	<.01	<.01	<.01
Toluene (mg/kg)	<0.2	<0.2	<0.2	<0.2	<0.2	.033	<.01	.016	.029	.024
Ethylbenzene (mg/kg)	<0.2	<0.2	<0.2	<0.2	.24	.014	<.01	<.01	<.01	<.01
Xylenes (mg/kg)	<0.2	<0.2	<0.2	<0.2	1.01	.105	<.02	<.02	<.02	<.02
Moisture (%)	NS	NS	NS	NS	NS	17.8	8.1	19.6	20.8	17.1

[a/] TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.
[b/] Initial soil gas samples collected on 7/7/92.
[c/] 1-Year soil gas samples collected on 7/19/93.
[d/] Average of two duplicate samples.
[e/] No sample could be collected due to subsurface obstruction; NS=Not Sampled.
[f/] Initial soil samples collected by D+W Construction on 5/19/92.
[g/] 1-Year soil samples collected by Montgomery-Watson, Inc. on 11/19/92.



LEGEND:

- VAPOR MONITORING POINT
- CENTRAL VENT WELL
- EXISTING SOIL BOREHOLE LOCATION
- EXISTING MONITORING WELL LOCATION
- FENCE
- RAILROAD

FIGURE 1

AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS IRP SITE ST-04 POL AREA

K.I. SAWYER AFB, MICHIGAN

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

26813-03, 10/15/92 at 10:21

TABLE 1
IRP SITE ST-04 POL AREA
RESPIRATION AND DEGRADATION RATES
K.I. SAWYER AFB, MICHIGAN

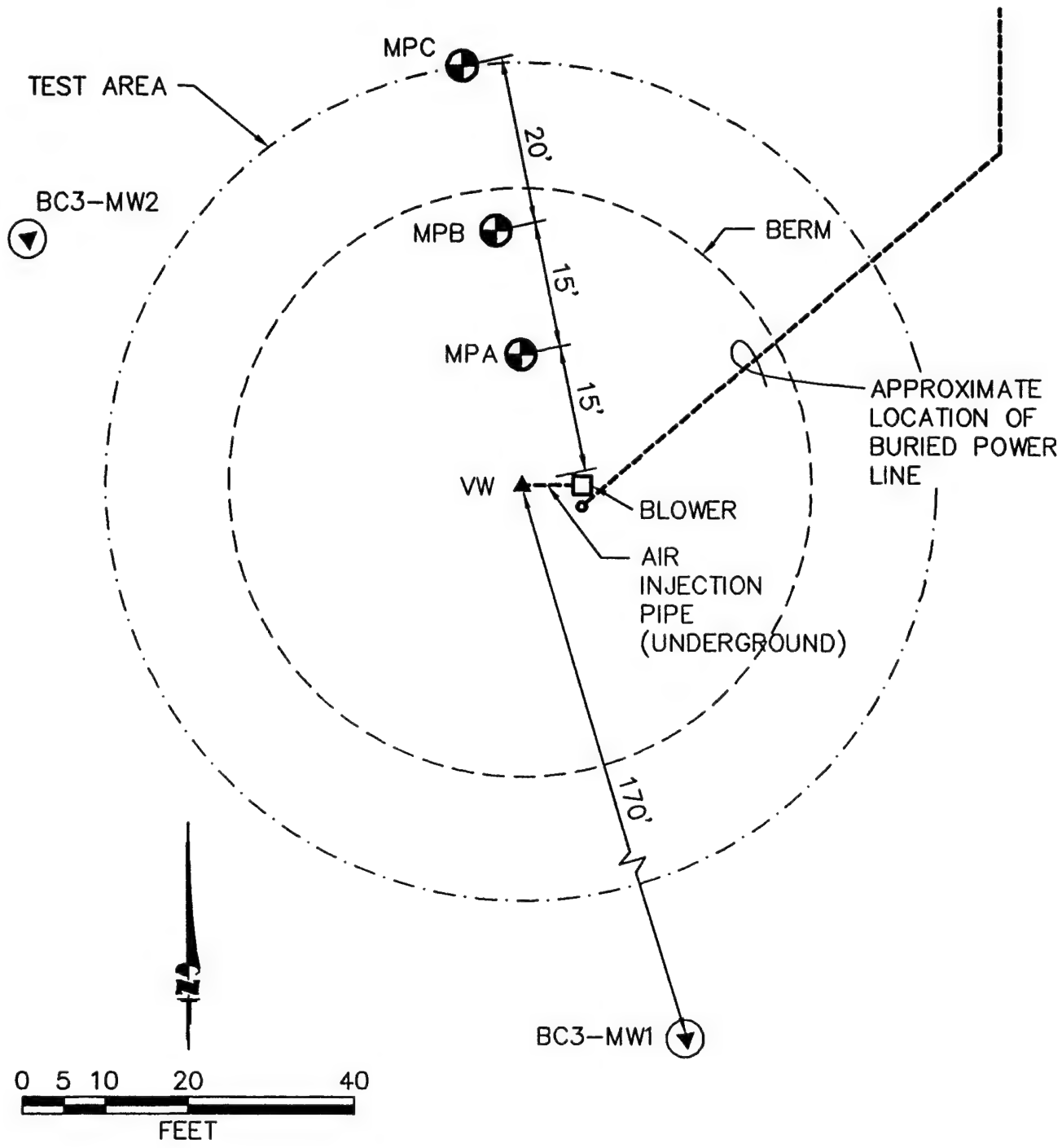
Location-Depth	Initial			6-Month[b/]			1-Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-15	0.0026	634	12.2	0.0028	780	16.7	0.0072	1700	32.8
MPA-35	0.00049	10	NS[c/]	0.00013	14	NS	0.00036	100	NS
MPA-60	0.00066	14	8.9	0.000074	16	8.9	0.000067	20	8.7
MPB-15	0.0039	423	NS	0.0048	760	NS	0.0059	1400	NS
MPB-35	0.0020	477	NS	0.0025	450	NS	0.0039	790	NS
MPC-15	NS	NS	NS	0.0015	240	NS	0.00087	200	NS
MPC-35	0.0010	159	NS	0.0011	180	NS	0.00015	35	NS

[a/] Milligrams hydrocarbons per kilogram soil per year.
[b/] Average moisture between initial and 1-Year readings is used for degradation rate calculation.
[c/] Not sampled.

TABLE 2
IRP SITE ST-04 POL AREA
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
K.I. SAWYER AFB, MICHIGAN

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)					
	VW		MPA-35		MPC-15	MPB-35
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	48,000	8.6	70,000	760	5,200	2,700
Benzene (ppmv)	240	0.004	930	<0.051	7.6	<0.20
Toluene (ppmv)	140	0.013	390	<0.051	4.4	<0.20
Ethylbenzene (ppmv)	10	0.012	17	<0.051	<0.55	5.0
Xylenes (ppmv)	17	0.020	28	0.18	0.80	14
	VW-16		MPA-38		MPB-36	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,700	54	670	4,200	1,400	3,620
Benzene (mg/kg)	<0.66	<0.039	<0.65	<0.08	<6.6	<0.34
Toluene (mg/kg)	5.7	<0.048	5.7	<0.099	110	<0.41
Ethylbenzene (mg/kg)	2.5	<0.04	1.6	<0.082	25	1
Xylenes (mg/kg)	7.8	<0.17	4.6	<0.35	70	23
Moisture (%)	8.8	3.0	19.4	5.8	11.7	9.3

[a/] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram; TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
[b/] Initial soil gas samples collected on September 21, 1992.
[c/] Final soil gas samples collected on October 7, 1993.
[e/] Initial soil samples collected on September 14-15, 1992.
[f/] Final soil samples collected on September 23, 1993.



LEGEND

MPA ⊕ MONITORING POINTS

VW ▲ CENTRAL VENT WELL (AIR INJECTION)

BC3-MW1 ⊛ EXISTING GROUNDWATER MONITORING WELL (USED FOR BACKGROUND MONITORING POINT)

FIGURE 1

AS-BUILT
VENT WELL, VAPOR MONITORING POINT, AND BLOWER LOCATIONS
IRP SITE 3
FIRE TRAINING AREA

Battle Creek ANGB, Michigan

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

26814-06, 10/27/92 at 10:22

TABLE 1
IRP SITE 3 FIRE TRAINING AREA
RESPIRATION AND DEGRADATION RATES
BATTLE CREEK ANGB, MICHIGAN

Location–Depth	Initial			6–Month[b/]			1–Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°F)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°F)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°F)
MPA–8	0.015	3683	67	0.0048	1173	54	0.0106	2270	89
MPA–17	0.007	2028	--	0.0030	866	--	0.0043	1143	--
MPA–27	0.002	580	46	--	--	56	--	--	62
MPB–8	--	--	--	0.0010	253	--	0.0011	307	--
MPB–17	0.002	580	--	0.0026	759	--	0.0004	86	--
MPC–8	--	--	--	0.00005	12	--	0.0000	13	--
MPC–17	--	--	--	0.00008	23	--	0.0000	0	--

[a/] Milligrams hydrocarbons per kilogram soil per year
[b/] Assumes moisture content of the soil is the same as the initial readings.

TABLE 2
IRP SITE 3 FIRE TRAINING AREA
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
BATTLE CREEK ANGB, MICHIGAN

Analyte (Units)[a]	Sample Location-Depth (feet below ground surface)					
	VW		MPA-8		MPC-17[b]	
Soil Gas Hydrocarbons	Initial[c]	1-Year[d]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	29,000	1.5	3,600	21	88	1.3
Benzene (ppmv)	120	<0.002	29	<0.002	0.057	<0.002
Toluene (ppmv)	50	<0.002	3.3	0.006	0.036	<0.002
Ethylbenzene (ppmv)	4.4	<0.002	3.9	<0.002	<0.010	<0.002
Xylenes (ppmv)	22	<0.002	11	<0.002	0.010	<0.002
	VW-8		MPA-7		MPB-18	
Soil Hydrocarbons	Initial[f]	1-Year[g]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	15,000	3,140	6,800[b]	1,580	120	<5.4
Benzene (mg/kg)	<0.13	<0.065	<0.32	<0.0005	0.004	<0.0005
Toluene (mg/kg)	7.0	<0.065	0.32	<0.0005	0.004	<0.0005
Ethylbenzene (mg/kg)	2.8	<0.065	4.4	<0.0005	<0.0005	<0.0005
Xylenes (mg/kg)	23.0	<0.091	8.9[b]	<0.0007	<0.0009	0.0017
Moisture (%)	6.2	4.0	5.3	3.8	2.6	7.3

[a] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram; TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; $CaCO_3$=calcium carbonate; TKN=total Kjeldahl nitrogen.

[b] Results averaged with duplicate sample.

[c] Initial soil gas samples collected on September 11, 1992.

[d] 1-Year soil gas samples collected on October 27, 1993.

[e] ND=not detected.

[f] Initial soil samples collected on September 9 and 10, 1992.

[g] 1-Year soil samples collected on October 25, 1993.

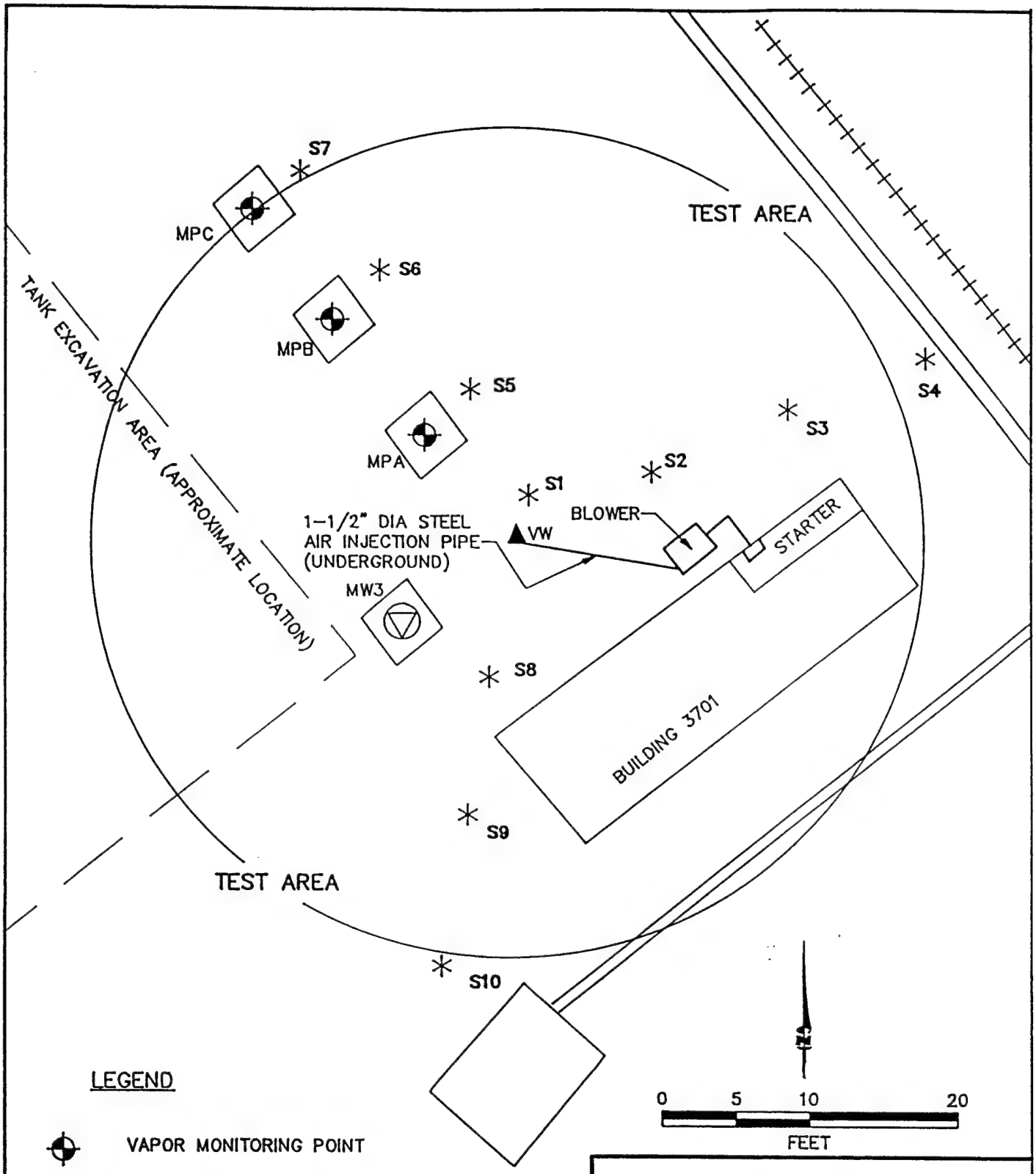


FIGURE 1

AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS POL STORAGE AREA C

TINKER AFB, OKLAHOMA

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

26816-01, 12/23/92 at 15:23

TABLE 1
POL AREA 3
RESPIRATION AND DEGRADATION RATES
TINKER AFB, OKLAHOMA

Location–Depth	Initial			6–Month[b/]			1–Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA–5	0.0053	900	17.3	0.0020	320	15.1	0.00088	120	9.5
MPA–10	NS[c/]	NS	NS	NS	NS	NS	0.00013	30	NS
MPA–15	0.0021	420	20.1	0.000065	13	18.6	0.000093	19	16.2
MPB–5	NS	NS	NS	NS	NS	NS	0.00099	170	NS
MPB–10	0.0026	610	NS	0.00056	130	NS	0.0011	260	NS
MPB–15	0.0024	480	NS	0.00014	28	NS	0.00064	130	NS
MPC–5	NS	NS	NS	NS	NS	NS	0.0017	250	NS
MPC–10	0.0031	720	NS	0.00055	130	NS	0.0017	400	NS
MPC–15	0.0025	500	NS	0.00043	87	NS	0.0011	220	NS

[a/] Milligrams hydrocarbons per kilogram soil per year
[b/] Moisture content an average of initial and final readings.
[c/] NS = Not Sampled.
REV01/6/8/94

TABLE 2
POL AREA 3
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
TINKER AFB, OKLAHOMA

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)					
	VW		MPA-5		MPC-10	MPC-15
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	940	2.4	3,500	34	30,000	530
Benzene (ppmv)	<0.21	0.003	100	<0.002	59	0.049
Toluene (ppmv)	6.3	<0.002	120	0.052	180	<0.025
Ethylbenzene (ppmv)	1.1	0.005	17	0.071	15	2.1
Xylenes (ppmv)	3.2	0.017	55	0.23	51	2.9

	VW-5		MPA-5		MPB-5	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,100	<5.5	5800	<5.8	5	<5.6
Benzene (mg/kg)	<2.7	<0.0006	4.3	0.003	<0.0006	<0.0006
Toluene (mg/kg)	120	0.0016	15	<0.0029	<0.0008	0.0013
Ethylbenzene (mg/kg)	140	<0.0006	19	0.014	<0.0005	<0.0006
Xylenes (mg/kg)	130	<0.0008	120	0.11	<0.001	<0.0008
Moisture (% by wt.)	9.6	8.7	10.7	13.1	7.8	11.3

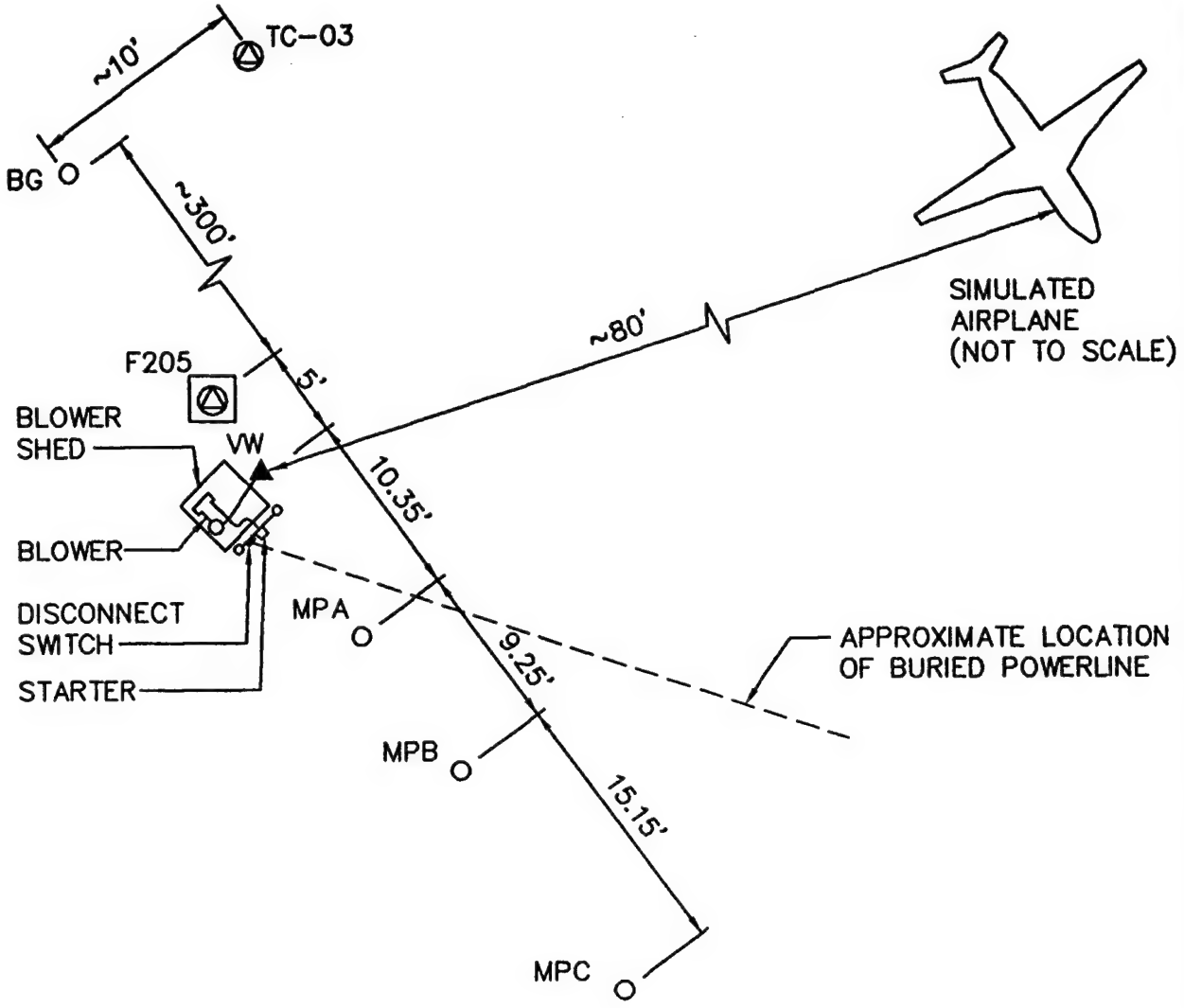
[a/] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram; TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume; $CaCO_3$=calcium carbonate; TKN=total Kjeldahl nitrogen.

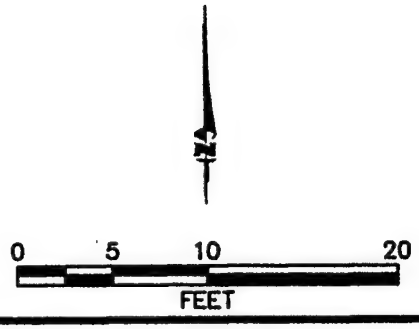
[b/] Initial soil gas samples collected on November 14, 1992.

[c/] 1-Year soil gas samples collected on January 29, 1994.

[d/] Initial soil samples collected on November 11 and 12, 1993.

[e/] 1-Year soil samples collected on January 27, 1994.





LEGEND

- EXISTING GROUNDWATER MONITORING WELL
- VW ▲ CENTRAL VENT WELL (AIR INJECTION)
- MPA O MONITORING POINT

FIGURE 1

SITE FC-2
AS-BUILT SITE PLAN

KELLY AFB, TEXAS

ENGINEERING-SCIENCE, INC.

Denver, Colorado

TABLE 1
SITE FC-2
RESPIRATION AND DEGRADATION RATES
KELLY AFB, TEXAS

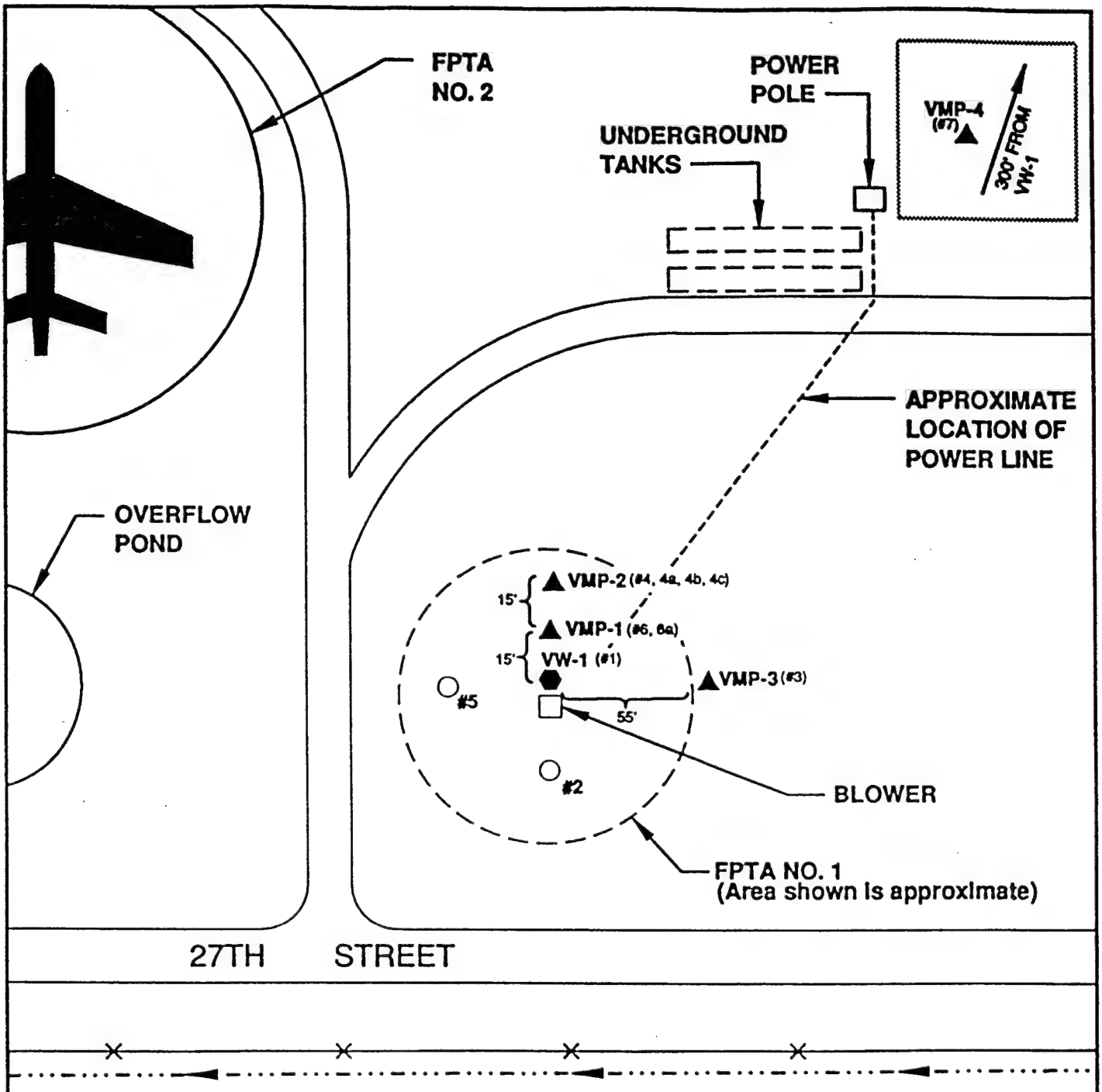
Location-Depth (feet bgs)	Initial = December 1992			6-Month = June 1993			1-Year = January 1994		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate[b/] (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-4	NS[c/]	NS	18.0	NS	NS	26.9	NS	NS	16.7
MPA-13.5	0.040	8100	24.9	0.013	2600	26.4	0.0058	1200	26.4
MPB-9	0.021	3500	NS	0.0039	480	NS	0.0023	180	NS
MPB-13.5	0.025	4200	NS	0.0019	230	NS	0.0083	650	NS
MPC-13.5	0.040	6700[d/]	NS	0.029	3600[d/]	NS	0.022	1700[d/]	NS

[a/] Milligrams hydrocarbons per kilogram soil per year.
[b/] Assumes moisture content of the soil is average of initial and final moistures.
[c/] Not Sampled.
[d/] Degradation rate calculated assuming MPC-13.5 soil moisture content the same as MPB-13.5.

TABLE 2
SITE FC-2
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
KELLY AFB, TEXAS

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)					
	VW		MPA-13.5		MPC-13.5	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	4,200	2.0	16,000	98	17,000	200
Benzene (ppmv)	14	<0.002	58	<0.004	43	<0.025
Toluene (ppmv)	7.4	0.02	20	0.28	18	1.5
Ethylbenzene (ppmv)	7	0.008	24	0.093	24	0.35
Xylenes (ppmv)	5.4	0.029	19	0.29	22	0.71
	VW-15		MPA-14		MPB-14	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	280	34.1	3,500	73.5	1,100	83.8
Benzene (mg/kg)	<0.38	<0.0006	<1.5	0.001	<0.38	<0.084
Toluene (mg/kg)	9.1	0.0056	12.0	0.027	2.9	0.36
Ethylbenzene (mg/kg)	<0.31	<0.0006	<1.2	0.001	<0.32	<0.084
Xylenes (mg/kg)	11.0	0.0009	40.0	0.0059	15.0	<0.12
Moisture (%)	20.0	16.3	19.4	19.2	20.8	25.9

[a/] TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.
[b/] Initial soil gas samples collected in December 1992.
[c/] 1-Year soil gas samples collected in January 1994.
[d/] Initial soil samples collected in December 1992.
[e/] 1-Year soil samples collected in January 1994.



EXPLANATION

⬢ VW-1 (#1)	VW LOCATION (and soil boring number)
▲ VMP-2 (#4)	VMP LOCATION (and soil boring number)
○ #5	ABANDONED SOIL BORING (and soil boring number)

N

0 50 100

SCALE IN FEET

FIGURE 1

AS-BUILT VW, VMP, AND BLOWER LOCATIONS

IRP SITE 3
FIRE PROTECTION TRAINING AREA NO. 1

BEALE AIR FORCE BASE
CALIFORNIA

C242-42/R2 120992

ENGINEERING-SCIENCE, INC.

TABLE 1
SITE 3
RESPIRATION AND DEGRADATION RATES
BEALE AFB, CALIFORNIA

Location–Depth	Initial – November 1992			6–Month–July 1993			1–Year–March 1994		
	K_o (%O_2/min)	Degradation Rate (mg/kg/year)/b	Soil Temperature (°C)	K_o (%O_2/min)	Degradation Rate/c (mg/kg/year)	Soil Temperature (°C)	K_o (%O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VMP1–8	NS/a	NS	25.3	0.0039	40	25.1	NS	NS	18.5
VMP1–14	0.0032	170	21.8	0.00013	10	21.7	0.00034	30	21.6
VMP1–24	0.00048	30	NS	0.00012	10	NS	0.00034	40	NS
VMP2–8	NS	NS	NS	NS	NS	NS	NS	NS	NS
VMP2–14	0.0040	210	NS	0.0	0	NS	0.00037	30	NS
VMP2–24	NS	NS	NS	NS	NS	NS	NS	0	NS
VMP3–8	NS	NS	NS	0.00015	0	NS	NS	NS	NS
VMP3–14	NS	NS	NS	0.0	0	NS	NS	NS	NS
VMP3–24	NS	NS	NS	NS	NS	NS	NS	NS	NS
VMP4–8	NS	NS	NS	NS	NS	NS	0.0	NA/d	NS
VMP4–15	NS	NS	NS	NS	NS	NS	0.0	NA	NS
VMP4–24	NS	NS	NS	NS	NS	NS	0.0	NA	NS
VW1	0.0018	90	NS	NS	NS	NS	0.0	0	NS

Notes:
/a = Not Sampled.
/b = Milligrams hydrocarbons per kilogram soil per year.
/c = Assumes moisture content of the soil is average of initial and final moistures.
/d = Not Applicable (Background Well).

TABLE 2
SITE 3
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
BEALE AFB, CALIFORNIA

Analyte (Units)[a/]	Sample Locations-Depth (feet below ground surface)					
	VW-1		VMP1-8		VMP3-14	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	4,000	7.4	4,800	780	150	11
Benzene (ppmv)	3.1	<0.002	3.8	0.81	0.054	0.004
Toluene (ppmv)	2.2	<0.002	3.6	1.8	0.016	<0.002
Ethylbenzene (ppmv)	1.4	<0.002	0.72	2.6	<0.002	0.003
Xylenes (ppmv)	3.4	0.002	3.6	5.9	0.002	0.011
	VW1-10		VMP1-9		VMP2-9	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	25,000	22,100	7,400	8,010	9,800	41.2
Benzene (mg/kg)	3.2	<0.078	<0.82	<0.32	<1.5	<0.077
Toluene (mg/kg)	8.2	<0.078	3.1	<0.32	3.1	<0.077
Ethylbenzene (mg/kg)	8.2	<0.078	1.7	0.94	<1.3	0.24
Xylenes (mg/kg)	38	0.26	5.8	3.1	7.8	0.76
Moisture (%)	21.8	20.4	27.3	23.0	22.2	19.2

[a/] TVH = total volatile hydrocarbons; ppmv = parts per million, volume per volume;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.
[b/] Initial soil gas samples collected on October 29, 1992.
[c/] Final soil gas samples collected on March 22, 1994.
[d/] Initial soil samples collected on October 19-23, 1992.
[e/] Final soil samples collected on March 15, 1994.

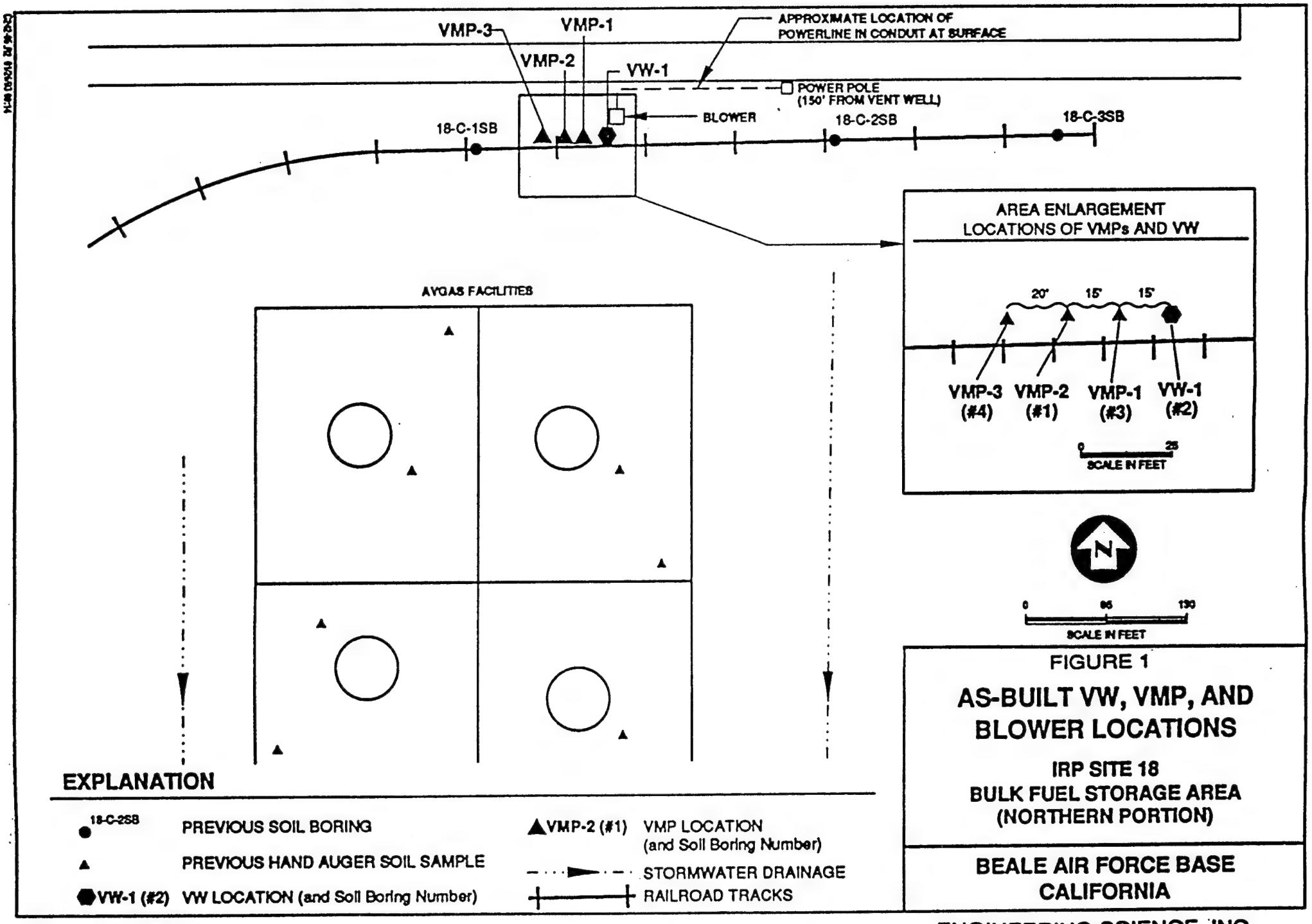


FIGURE 1

AS-BUILT VW, VMP, AND BLOWER LOCATIONS

IRP SITE 18
BULK FUEL STORAGE AREA (NORTHERN PORTION)

BEALE AIR FORCE BASE CALIFORNIA

ENGINEERING-SCIENCE, INC.

TABLE 1
SITE 18
RESPIRATION AND DEGRADATION RATES
BEALE AFB, CALIFORNIA

Location–Depth	Initial – November 1992			6–Month–July 1993			1–Year–January 1994		
	K_o (%O_2/min)	Degradation Rate (mg/kg/year)/b	Soil Temperature (°C)	K_o (%O_2/min)	Degradation Rate/c (mg/kg/year)	Soil Temperature (°C)	K_o (%O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VMP1–6	0.0400	590	21.4	0.0034	400	25.5	0.0035	940	16.1
VMP1–11	0.0048	510	NS	0.00045	50	NS	0.00054	140	NS
VMP1–30	NS/a	NS	NS	0.0	0	NS	0.00017	50	NS
VMP1–65	NS	NS	20.1	NS	NS	19.9	NS	NS	20.5
VMP2–6	NS	NS	NS	0.0029	0	NS	0.0012	10	NS
VMP2–11	0.0037	390	NS	0.00040	0	NS	0.0013	10	NS
VMP2–30	NS	NS	NS	NS	NS	NS	NS	NS	NS
VMP2–65	NS	NS	NS	NS	NS	NS	NS	NS	NS
VMP3–6	NS	NS	NS	0.00049	0	NS	0.0010	10	NS
VMP3–11	NS	NS	NS	0.00020	0	NS	0.00039	0	NS
VMP3–30	NS	NS	NS	0.0	0	NS	0.0	0	NS
VMP3–55	0.00063	0	NS	0.0	0	NS	0.0	0	NS
VW1	NS	NS	NS	NS	NS	NS	0.0	0	NS

Notes:
/a = Not Sampled.
/b = Milligrams hydrocarbons per kilogram soil per year.
/c = Assumes moisture content of the soil is average of initial and final moistures.

TABLE 2
SITE 18
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
BEALE AFB, CALIFORNIA

Analyte (Units)[a/]	Sample Locations-Depth (feet below ground surface)					
	VW-1		VMP1-6		VMP3-6	
Soil Gas Hydrocarbons	Initial[b/]	1-Year[c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	1,500	3.2	1,400	840	7,900	4,100
Benzene (ppmv)	2.0	<0.002	1.1	<0.05	31	14
Toluene (ppmv)	0.65	<0.002	1.1	<0.05	3.0	<0.51
Ethylbenzene (ppmv)	2.1	<0.002	1.2	1.0	2.7	1.4
Xylenes (ppmv)	2.3	<0.002	2.4	1.7	0.76	3.5
	VW1-11		VMP1-12		VMP2-11	
Soil Hydrocarbons	Initial[d/]	1-Year[e/]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	24,000	16,500	40,000	11.7	3,900	354
Benzene (mg/kg)	<1.6	<0.16	<0.41	<0.069	<0.4	<0.17
Toluene (mg/kg)	2.0	<0.16	0.75	<0.069	1.5	<0.17
Ethylbenzene (mg/kg)	6.7	<0.16	0.52	<0.069	2.7	<0.17
Xylenes (mg/kg)	16	<0.23	<0.62	<0.097	7.8	<0.24
Moisture (%)	24.8	24.5	26.9	10.1	26.5	24.8

[a/] TVH = total volatile hydrocarbons; ppmv = parts per million, volume per volume;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram;
[b/] Initial soil gas samples collected on November 12, 1992
[c/] Final soil gas samples collected on January 22, 1994
NS = not sampled
[d/] Initial soil samples collected on November 2-3, 1992
[e/] Final soil samples collected on March 15, 1994

Beale\S18tbl2\brb\6-9-94

TABLE 1
SITE FT-03
RESPIRATION AND DEGRADATION RATES
CHARLESTON AFB, SOUTH CAROLINA

Location-Depth	Initial = November 1992			6-Month = May 1993			1-Year = November 1993		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate[d/] (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-3.5	NA[a/]	NA	NA	0.0046	270	19.7	0.00085	120	16.9
MPB-3.5	NA	NA	NA	0.0018	110	NS	0.00045	60	NS
MPC-3.25	NA	NA	NA	NS[c/]	NS	NS	0.00036	70	NS
MPD-1.8	NA	NA	NA	0.0031	370	NS	0.0028	510	NS
MPD-3.9	0.0088	580	19.0	0.014	1690	19.3	0.0025	450	17.3

[a/] Not Available - Point was submerged.
[b/] Milligrams hydrocarbons per kilogram soil per year.
[c/] Not Sampled.
[d/] Assumes moisture content of the soil is average of initial and final moistures.

TABLE 2
SITE FT-03
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
CHARLESTON AFB, SOUTH CAROLINA

Analyte (Units)[a]	Sample Location-Depth (feet below ground surface)					
	MPA-3.5		MPC-3.25		MPD-3.9	
Soil Gas Hydrocarbons	Initial[b]	1-Year[c]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	27	0.47	NS[d]	0.78	790	13
Benzene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Toluene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Ethylbenzene (ppmv)	<0.002	<0.002	NS	0.002	0.12	<0.002
Xylenes (ppmv)	0.002	<0.002	NS	<0.002	0.22	<0.002
	VW-3.5		MPA-2.5		MPD-3	
Soil Hydrocarbons	Initial[e]	1-Year[f]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,100	170	51	12	2,200	2,200
Benzene (mg/kg)	<0.73	<0.0027	<0.72	<0.0006	<1.4	<0.54
Toluene (mg/kg)	2.6	<0.0027	2.7	<0.0006	<1.1	<0.54
Ethylbenzene (mg/kg)	1.6	<0.0027	<0.6	<0.0006	<1.6	<0.54
Xylenes (mg/kg)	4.6	<0.0038	1.3	<0.0006	<2.1	<0.75
Moisture (%)	17.9	8.5	16.8	9.1	12.6	6.6

[a] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram;
TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
[b] Initial soil gas samples collected on May 6, 1993
[c] Final soil gas samples collected on November 11, 1993
[d] NS=not sampled.
[e] Initial soil samples collected on October 29, 1992
[f] Final soil samples collected on November 11, 1993

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